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ABSTRACT

The author's previously developed theory on income distribution, in which two of the explanatory variables are the average level and the distribution of education, is refined and tested on data selected and processed by the author and data from three studies by Americans. The material consists of data on subdivisions of three countries, the United States, Canada, and the Netherlands. The main difference between the author's theory and those of the others is the introduction of demand by the "organizers of production" for skill or qualification alongside with supply. One of the points of focus of this essay consists of attempts to give practical shape to the introduction of variables supposed to represent demand. The theoretical base is advanced in the first section, followed by a discussion of some characteristics of the testing material used. In the remaining sections of the essay some results obtained for the three countries mentioned are shown and compared with results obtained by others. (Author/MLF)

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THE IMPACT OF EDUCATION ON INCOME DISTRIBUTION

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1. Introductory

In a recent article I made attempts to test, by multiple correlation calculations, some versions of theories on income distribution in which one or two of the explanatory variables are the average level and the distribution of education [7]. Since I wrote that article new material has come to my knowledge which made it tempting also to use this material for the same purpose. Three studies by Americans, namely T. Paul Schultz [6], Leland S. Burns and H.E. Frech III [1] and Barry R. Chiswick [2,3], based on an interesting and large amount of information, have been the basis for the present study, which also contains some material selected and processed by the present author. The material consists of data on subdivisions of three countries, the United States, Canada and The Netherlands. Although the authors mentioned adhere to theories of income distribution somewhat different from my own theory [8], their material can be used also to test the latter, subject to some assumptions. The material added by my own modest extension seems to fit the purpose somewhat better, however, and suggests some further research in that direction. The present article constitutes a progress report only, to be followed by further work. As set out already briefly in the work quoted, the main difference between my theory and those of the present American school, grouped around such well-known authors as T.W. Schultz, A. Mincer and others, is that I introduce demand by the "organizers of production" for skill or qualification alongside with supply. Demand has been mentioned by T.P. Schultz [6, p. 13], but

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* I want to express my sincere thanks to my collaborators A. ten Kate, M.Sc. and H. Visscher for the programming of many calculations used in this article.

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not included in his explanatory variables. One of the points of focus of this essay therefore consists of attempts to give practical shape to the introduction of variables supposed to represent demand. But I also want to add an omission in some previous presentations of this demand-supply theory. Together with a few more refinements the theoretical base chosen will be set out in Section 2. Some characteristics of the testing material used will be discussed in Section 3. In the remaining sections some results obtained for the three countries mentioned will be shown and compared with results obtained by others.

2. The Demand-Supply Theory of Income Distribution

The simplest theories of price formation for single commodities can be summarized by saying that they assume the existence of a demand equation and a supply equation, both containing the quantities traded and the price as variables. In the demand equation one or more other variables are added characterizing the position of those who demand; in the supply equation one or more variables are added characterizing the position of suppliers. These additional variables have been indicated as demand factors and supply factors, respectively. By the elimination of quantities traded we can retain a "price formation equation" which explains the price in terms of the demand and the supply factors. In a way the difference between the values of the demand factors and those of the supply factors, when brought on some common denominator, can be called the tension between demand and supply quantities just mentioned. This is why I sometimes indicated the demand-supply theory as the "tension theory". We can consider as a dummy variable for demand factors the number of people of a certain skill needed by the organizers of production and as one of the dummy variables for supply factors the number of people which by their education and [1] Its contents could be briefly summarized by the proposition that high incomes will be paid to qualifications for which there is a high tension and low income to qualifications for which there is a low, even a "negative" tension, namely where supply surpasses demand. The income distribution may then be derived from the distribution of qualifications required and qualifications available. Incomes could

[1] other factors possess this skill.

become almost equal if there is no tension between the two distributions. People would not need to be of equal productive quality in order to attain this near-equality of incomes.

One condition to be fulfilled for any attempt to test the demand-supply theory is that the geographical units compared in a cross-section or time series analysis be large enough to contain both the demand and the supply location. For commuters there is a distinction between the place where they work (and where the demand is exerted) and the place where they live (wehre the supply is shown). This implies that cross section studies using single municipalities, such as the Burns-Frech study and some of T.P. Schultz's investigations, may lead to unreliable results. For that reason I have preferred to use data for the (eleven) provinces of the Netherlands only, as also done by Schultz.

3. Material Used in the Present Study; some Lacunae

As already observed, this study deals with cross-section analyses for three countries. The figures refer to the states of the United States (Chiswick), the provinces of Canada (same author) and a number of municipalities (Burns and Frech), the socio-geographic areas and the provinces of the Netherlands (Schultz, Tinbergen). Burns and Frech in particular have chosen the 71 largest municipalities, Schultz 88 selected at random and both Schultz and I took the eleven provinces of my country. The advantage of the type of material chosen consists of homogeneity in cultural and other respects, partly unknown even, which does not exist for cross section studies among widely differing countries as carried out by Lydall [4] and myself [7]. This homogeneity is also lacking in time series studies, because of changes both in the system of education and in the technology of production.

There are also disadvantages connected with cross-section studies within a single country; one was mentioned already: commuters do not always work and live in the same geographical unit. Another is that variations within one country, especially a small country, may be

so restricted as to be a hindrance to extrapolations, which are the main instruments to arrive at the more interesting answers we want to derive from our studies.

Finally the material used in this article suffers from some lacunae because time did not permit me to calculate the demand variable (which for the Netherlands gave the best results) for the two larger countries. It is my hope that this lacuna can be filled up on a later occasion. Similarly, the yardsticks used for income inequality have been different and also this lacuna may be filled later. The variables used in this article have been listed and defined in Table I.

Table I. List of variables used by authors quoted (USA = United States of America; CDN = Canada, NL = Netherlands).

		NL		
Symbol	Chiswick (UAS + CDN)	Schultz	Burns and Frech	Tinbergen
X	X: Variance of nat. logs of income in $ 1000	X': concentrat. Ratio of Inc.	X': Concentr. ratio of Inc.	X'': Highest Decile of Income
Y	Y: Average of nat. logs of income in $ 1000	*	Y': Income in hfl. 1000	Y'': Demand index 3)
Z	Z: Average number of years of schooling, males over 25	Z': Males 40-64: % with higher educ. 1)	Z'': Years of schooling 2)	Z''': Percent of active pop. with sec. and higher ed.
U	U: Variance in number of years of schooling, males over 25	*	U': Conc. ratio of schooling	U'': Percent of act. pop. with higher ed.
V	V: Nat. log of Y_0 (income at zero schooling)	*	*	*

Note: capital letters are used for variables in units indicated; lower case letters will be used for "normalized" variables (i.e. average = 0, standard deviation = 1). * means: variable not used.

1) For 1960 Percentage of active males with higher education.
2) Total Population.
3) Defined in text (Section 7).

4. Using Chiswick's Material for the United States

For each of the data collections analysed we used two ways of measuring the variables used; the "natural units" as indicated in Table I and normalized units (with zero average and unit standard deviation); the latter being indicated by lower case letters. We attempted to study the structure of relationship by comparing repression coefficients found in different combinations for the same variable. Chiswick's material on the United States was used to construct Table II.

Table II. Regression and multiple correlation coefficients (R) found for different combinations of variables explaining income inequality x.

No.	Regression coefficients for explanatory variable					
	y	z	u	v	R	
1	-0.79	.	.	.	0.79	1 expl.var.
2	.	-0.73	.	.	0.73	
3	.	.	+0.48	.	0.48	
4	.	.	.	-0.86	0.86	
5	-0.60	-0.23	.	.	0.80	2 expl.var.
6	-0.71	.	+0.25	.	0.825	
7	+0.08	.	.	-0.94	0.86	
8	-0.82	+0.15	+0.31	.	0.83	3 expl.var.
9	+1.25	-0.67	.	-1.58	0.93	
10	+0.65	.	+0.42	-1.38	0.94	
11	+1.02	-0.33	+0.315	-1.52	0.94	4 expl.var.

Source: [3], Table 3-3.

We did not use all the variables shown in Chiswick's study, for instance not his variable $\hat{r}$, the rate of return on education derived for each state from the regression, in that state, of income over schooling. My feeling was that its use would duplicate the variables Z and U, since Chiswick's (and Mincer's) theory is that the choice of

everybody's length of schooling is partly based on $\hat{r}$. It seems that indeed $\hat{r}$ is superfluous, even statistically; there appears to be complete multicollinearity in the set (x, y,z, u,v, $\hat{r}$).

The following conclusions seem warranted:

The influence exerted by variables u (education inequality) and v (representing other influences on income, such as innate capabilities) are stable; variable v always raises considerably the correlation coefficient. The contribution of u is less important, but stable. The influence of y, taken here to represent the demand for qualified manpower, looks uncertain, since positive as well as negative regression coefficients are found. Negative coefficients occur when and only when v is excluded. The cases with the highest multiple correlation coefficients show a positive regression coefficient for y. The influence exerted by variable z is negative in most cases. These statements induce me to select case no. 11 as the most satisfactory relationship found with the aid of Chiswick's material.

Using natural units we must divide the corresponding symbols by their standard deviations, given below (source: [3] Table G-5): $\sigma_n = 0.12$; $\sigma_y = 0.23$; $\sigma_z = 0.79$; $\sigma_u = 3.17$; $\sigma_v = 0.29$; the relation then becomes:

$$X = 0.53\ Y - 0.05\ Z + 0.012\ U - 0.63\ V \qquad (4.1)$$

As an illustration of the influence which a higher level and a more equal distribution of education may exert, we assume an increase in schooling years of 2 and a reduction of its variance by 4; such changes would lead to $\Delta X = -0.10 - 0.05 = -0.15$. Since the average value of X, that is $\bar{X} = 0.79$, this represents a very modest reduction of inequality in income in the United States; it reduces the standard deviation of incomes from $\sqrt{0.79}$ to $\sqrt{0.64}$ or from 0.89 to 0.80 or by 10 per cent only. As we shall see for the case of the Netherlands, the coefficients for Z and U may become larger, however, if Y is replaced by a better measure for demand.

5. Using Chiswick's Material for Canada

Chiswick has collected for Canada the same material as for the United States. Some of the results obtained with its aid are given in Table III.

Table III. Regression and multiple correlation coefficients R obtained from different combinations of variables explaining x.

No.	Regression coefficients for explanatory variable				R	
	y	z	u	v		
1	-0.62	.	.	.	0.62	one expl. variable
2	.	-0.54	.	.	0.54	
3	.	.	-0.15	.	0.15	
4	.	.	.	-0.67	0.67	
5	-0.55	-0.09	.	.	0.625	2 expl. variables
6	-0.85	.	+0.38	.	0.68	
7	+0.08	.	.	-0.74	0.67	
8	-1.93	+0.90	+0.91	.	0.76	3 expl. variables
9	+1.17	-0.49	.	-1.48	0,72	
10	+0.59	.	+0.82	-1.83	0.86	
11	+0.10	+0.27	+0.92	-1.61	0.86	4 expl. var.

Source: [3], Table 3-12.

From the table we see that the influence exerted by y and z is unstable, whereas the one exerted by u and v is relatively stable. Also, inclusion of u or v considerably raises the correlation coefficient. Transforming equation (11) into one with the units used by Chiswick and mentioned in Table I, we obtain:

$$\frac{X}{0.09} = 0.10\,\frac{Y}{0.21} + 0.27\,\frac{Z}{0.78} + 0.92\,\frac{U}{1.08} - 1.61\,\frac{V}{0.26}$$

or $$X = 0.043\,Y + 0.031\,Z + 0.077\,U - 0.56\,V \qquad (5.1)$$

In contrast with the result for the United States, there is a positive influence of the average level $\underline{Z}$ of education on income inequality $\underline{X}$; this implies that the average level would already be too high. A possible explanation may be in the fact that in Canada education is obligatory too a larger extent than in the United States; at least for Great Britain this argument is used by Chiswick [2] and in this respect Canada probably is somewhat closer to Britain than the United States.

Considering that $\bar{\underline{U}} = 10.69$, we may think of a reduction in the inequality of schooling as a means to reduce income inequality and estimate the influence of $\Delta\underline{U} = -5$, meaning that the standard deviation in years of schooling reduces from $\sqrt{10.69}$ to $\sqrt{5.69}$ or from 3.27 years to 2.36 years. We obtain:

$$\Delta X = -0.385 \qquad (5.2)$$

Since $\bar{\underline{X}} = 0.63$, this brings inequality as measured by $\underline{X}$ to less than one half, but when measured as a standard deviation in the natural logarithms of income from $\sqrt{0.63}$ to $\sqrt{0.445}$ or from 0.795 to 0.666, a reduction by 16 per cent only.

A common feature to the equations found for both the United States and Canada is that raising the Y_o, standing for other factors than schooling which determine an individual's productivity, reduces inequality in about the same way. This may in part reflect the influence of the "environment", among it the influence of the education of the parents. If this interpretation is correct, the long-run influence of education may be considerably stronger than the direct influence estimated.

6. Research on the Netherlands by T.P. Schultz and by L.S. Burns and H.E. Frech III

Schultz's contributions [5, p. 352] to the explanation of income inequality consist of having collected a vast collection of statistical data, for 11 provinces, for 75 regions and for 88 municipalities selected in a random sample (p. 339/340) and of having analysed various relations in order to explain changes over time with

the aid of various explanatory variables as well as of having studied cross section data. For this article the latter are the more relevant analyses. Income inequality among regions as well as among provinces, measured by their concentration ratio have been explained by a variety of variables, including the level of education, for which Schultz found a positive influence. No use is made of demand factors, which prevent us from testing the demand-supply theory. The other explanatory variables include number of tax payers, unemployment and wealth. The best results are obtained for the most recent year studied by him, 1958, and for the provinces. This seems to confirm the viewpoint that the geographical units should not be chosen too small. With the aid of the education level (measured as the percentage of active population having had higher education) a corrected correlation coefficient of 0.89 is obtained. This result comes close to my own results, to be discussed in Section 7.

Burns and Frech used the figures for 71 of the larger municipalities. Their material enabled me to compute Table IV, where the symbols are those explained in Table I.

Table IV. Regression and (multiple) correlation coefficients R found for different combinations of variables explaining income inequality $\underline{x}'$.

No.	Regression coefficients for : $\underline{R}$				
	$\underline{y}'$	$\underline{z}'$	$\underline{u}'$		
1	-0.91	.	.	0.91	1 expl. variable
2	.	-0.50	.	0.50	
3	.	.	-0.68	0.68	
4	-0.92	+0.02	.	0.91	2 expl. variables
5	-1.05	.	+0.175	0.91	
6	-1.04	-0.02	+0.177	0.91	3 expl. variables

Source: [1], Table 1b, and figures on $\underline{z}'$ kindly supplied by the authors.

These results may be interpreted so as to attach the main role in the explanation to incomes, with a clearly negative influence. The influence of the two education variables is secondary, with that of the level of education uncertain even as to its algebraic sign, whereas inequality of education shows a positive influence. If income y' can be considered as a demand indicator for high qualification, its influence should be positive and so interpreted the demand-supply theory is rejected. But I have some doubts, already announced, whether not the geographical units taken are too small. A group of typically commuter municipalities, whose commuters work in the nearby large cities Amsterdam, Rotterdam and The Hague, do not reflect the demand for the commuters' qualifications. They happen to have high incomes and at the same time low inequality of incomes. Later (Section 7) we will find that for the larger units, the provinces, a completely different situation prevails.

7. Further Research on the Netherlands

In an attempt to test the demand-supply theory I tried to construct a slightly more precise indicator for demand. From the American 1960 Census of Population quoted in [5] the percentage of the manpower with higher education was found for the four main sectors: agriculture, manufacturing, trade and transportation and services (defined as the remainder). For each of the Dutch provinces the total number of persons active in the four main sectors are known from the Dutch 1960 Census of Population. Multiplying the percentage with higher education needed, taken from American figures a (probably overestimated) index of demand was derived. On the supply side, two indicators were used, in order to open up the possibility of different weights to be given to manpower with secundary and manpower with third-level higher education. At the same time it was assumed that private cost of third level education is related with

income foregone, to be represented by a constant, reflecting income of people with secondary education only.

The demand-supply theory was given a shape better adapted to the data available. As the variable representing income inequality we considered the upper decile income divided by average income (in Lydall's [4] notation $\underline{P}_{10}$). Demand for and supply of people with higher education were represented by $\underline{d}_1 + \underline{d}_2$ and $\underline{s}_1 + \underline{s}_2$ respectively, where the indices 1 and 2 represent two subgroups: group 2 being university graduates and group 1 representing all other people with higher education. As set out in Section 2, the differences between demand and supply were taken as two explanatory variables, but the possibility was kept open that the weights of the two differences $\underline{d}_1 - \underline{s}_1$ and $\underline{d}_2 - \underline{s}_2$ could be different: a scarcity in category 2 may be more important to explain inequality than the same scarcity in category 1. Taking into account that in the absence of inequality X'' must be 1 and that our method of calculating quantities demanded is based on American figures, a formula of the following shape was tested:

$$X'' = \xi_1 (d_1 - s_1) + \xi_2 (d_2 - s_2) + 1 + c \qquad (7.1)$$

where $\underline{c}$ indicates the correction for the use of American figures. The data available do not permit us to introduce $\underline{d}_1$ and $\underline{d}_2$ separately, however. For this reason we combine $\xi_1 \underline{d}_1 + \xi_2 \underline{d}_2$ to $\xi \underline{Y}''$ and specify the correction term $\underline{c}$ to be $\xi (\bar{Y}'' - \bar{Y}_o'')$ where the suffix o refers to the United States. Replacing $\underline{s}_1$ and $\underline{s}_2$ by $\underline{Z}''' - \underline{U}''$ and $\underline{U}''$ (cf. Table I) respectively, we finally obtain, for the purpose of testing the demand-supply theory:

$$X'' = \xi Y'' - \xi_1 (Z''' - U'') - \xi_2 U'' + 1 + \xi(\bar{Y}'' - Y_o'')$$

Our best result obtained runs:

$$X'' = 1.21\ Y'' - 0.08\ Z''' - 1.16\ U'' - 11.4 \quad (\underline{R} = 0.96) \qquad (7.2)$$

This is equivalent to putting $\xi = 1.21$; $\xi_1 = 0.08$ and $\xi_2 = 1.08$.

This would leave us with an estimate of $\bar{Y}'' - \bar{Y}_o'' = -10.3$. The direct estimate of the percentage of active population with higher education in both countries yields

$$\bar{Y}'' = 10.4 \; ; \quad \bar{Y}_o'' = 19.1$$

implying a value for $\bar{Y}'' - Y_o'' = -8.7$. In order to test the stability of the regression coefficients found, we constructed Table V, comparable with Tables II, III and IV, using normalized variables.

Table V. Regression and multiple correlation coefficients R, found for different combinations of variables explaining income inequality x''

No.	Regression coefficients for explanatory variable			R	
	y''	z'''	u''		
1	0.84	.	.	0.84	one explanatory variable
2	.	0.81	.	0.81	one explanatory variable
3	.	.	0.70	0.70	one explanatory variable
4	1.03	-0.20	.	0.845	2 explan. variables
5	2.50	.	-1.72	0.95	2 explan. variables
6	2.95	-0.42	-1.75	0.96	3 expl. var.

The negative influence of the supply variables and the positive influence of the demand variable is confirmed by cases 4 and 5.

In order to compare these results with those for the two other countries and those obtained by Burns and Frech for the Netherlands (based on municipalities) we constructed similar tables for a few alternative variables; using y' instead of y'' (closer to Chiswick's material) in Table VI and x' instead of x'' (Burns and Frech) in Table VII.

Table VI. Regression and multiple correlation coefficients R found for different combinations of explanatory variables to explain x''.

No.	Regression coefficients for:			R
	y	z'''	u''	
1	0.88	.	.	0.88
2	.	0.81	.	0.81
3	.	.	0.70	0.70
4	0.92	-0.04	.	0.88
5	1.02	.	-0.17	0.88
6	0.89	+0.27	-0.31	0.89

Table VII. Regression and multiple correlation coefficients R found for different combinations of variables to explain x'

No.	Regression coefficients for:			R
	y''	z'''	u''	
1	0.92	.	.	0.92
2	.	0.89	.	0.89
3	.	.	0.90	0.90
4	0.87	-0.055	.	0.92
5	0.91	.	+0.092	0.92
6	0.89	-0.054	+0.083	0.92

The results presented in the last two tables are less satisfactory than those of Table V: the multiple correlation coefficients are lower and the supply influences are small and uncertain.

8. Some Preliminary Conclusions

The only case where, in the present essay, a considerable influence of the level and the inequality of education on income distribution is found, is equation (7.2). In order to reduce income

inequality, as measured by the highest decile divided by average income, to half of its 1960 value, that is, in order to attain $\Delta \underline{X} = -2$, we need $\underline{U}'' = \frac{2}{1.08} = 1.86$, meaning that the percentage of the population with university education should somewhat more than doubled in comparison to the 1960 situation, when it was 1.4 per cent. Such favourable results were found in several other cases reported on before [7, 9]; but most of the present results are much less favourable in that sense. From the various versions of the relationship found for the Netherlands one may wonder whether not perhaps the use of the demand indicator as defined in Section 7 might change the American and Canadian figures so as to show a stronger influence of education level or distribution on income inequality. Further work will be undertaken*.

Another conclusion seems to be that municipalities are too small units to compare, because of the different "location" of demand and supply in our sense.

In a last attempt to compare our cross section analyses we collect our "best" cases from the various tables in the order of goodness of fit (Table VIII).

Table VIII. Regression coefficients and R found in six cases[1].

Case	R	Regr.coeff.for $\underline{Y}$	$\underline{z}$	$\underline{u}$	$\underline{v}$	Country
A	0.96	2.95	-0.42	-1.75	.	Netherlands
B	0.94	1.02	-0.33	+0.315	-1.52	United States
C	0.92	0.89	-0.054	+0.083	.	Netherlands (provinces)
D	0.91	-1.04	-0.02	+0.177	.	Netherlands (munic.)
E	0.89	0.89	+0.27	-0.31	.	Netherlands (provinces)
F	0.86	0.10	+0.27	+0.92	-1.61	Canada (provinces)

1) Primes used to distinguish variables in Table I have been omitted in this table.

* It is also conceivable that a longer-term influence on income distribution may be implicit in the influence of variable $\underline{V}$, as already observed in Section 5, a suggestion made to me by J.P. Pronk, M.A. and substantiated for Norwegian samples by Soltow, L, Toward Income Equality in Norway, Madison 1965.

There are some regularities in this table worth mentioning. With the exception of case D, which we rejected because of the use of too small geographical units, the coefficients for y (or substitutes) fall and so do (even including case D) the negative coefficients for z (or substitutes). Where available, the influence of v, representing other factors making for quality, exert considerable influence. This is an argument in favour of introducing such additional variables, as done by Chiswick in an inventive way.

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